Variability of Irradiance in the Wave Boundary Layer

W. Scott Pegau
College of Oceanic and Atmospheric Sciences
104 COAS Admin Building
Oregon State University
Corvallis, OR 97331-5503
phone: (907) 424-7785 fax: (907) 424-5810 email: scott.pegau@gmail.com

Hemantha W. Wijesekera
Naval Research Laboratory
Code 7330, 104 Ocean Admin Bldg, Corvallis, OR 97331-5503
phone: (288) 688-4845 fax: (288) 688-4149 e-mail: hemantha.wijesekera@nrlssc.navy.mil

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LONG-TERM GOALS

Our primary goal is improve our understanding of the role of surface waves, bubble clouds, and near-surface oceanic processes on the spatial distribution of oceanic irradiance.

OBJECTIVES

The objectives are to:

- Measure the variance in the oceanic light field.
- Associate the variance in the light field with surface waves and variance in the inherent optical properties and physical properties.

APPROACH

We are using an autonomous underwater vehicle (AUV) to make spatial measurements of physical (near surface T, C, turbulence levels), and optical (a, c, bb, Ed) fields from sensors mounted on OSU's AUV. We are working with Satlantic to also incorporate a radiance camera within the AUV(Figure 1). By measuring the irradiance field at high frequency we will be able to provide the optical measurements needed to evaluate models of surface effects on the irradiance field (e.g., Zaneveld et al. 2001). The optical measurements will be combined with physical measurements to improve physical models associated with surface mixing.

To achieve high-resolution irradiance measurements we integrated two Biospherical single wavelength irradiance sensors into the Rockland Scientific Inc (RSI) microstructure sensor. This sensor has the high sampling rate that is needed to achieve small, spatial-scale irradiance measurements. At the normal operating speed of the AUV (~2 m/s) irradiance measurements at 100 Hz will provide cm-scale spatial resolution. Measurements of bulk absorption and attenuation coefficients are made using an ac-9 with water pumped to the instrument from the nose of the vehicle. Measurements of the

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backscattering coefficient and spectral irradiance will be collected with instruments penetrating the hull of the AUV. The Satlantic Radcam provides measurement of the downwelling radiance field.

Figure 1. The Odyssey III AUV prepared for deployment. Microstructure and conductivity-temperature-depth measurements are made in the nose cone. The irradiance sensors are visible at the top mid portion of the vehicle. The large black object with the bubble is the Satlantic radiance camera. The ac-9 and scattering sensors are mounted in the interior of the vehicle.

The AUV is being flown along several isobars to measure the light field, IOPs and physical properties. Along each isobar it is possible to determine the power spectrum of irradiance fluctuations and provide other statistics related to the variability in the light field (Figure 2). These statistics can then be compared to the variability in modeled light fields.

WORK COMPLETED

We tested the AUV system in July 2008 to ensure it was ready for the September 2008 deployment. We are currently participating in the September 2008 exercise. The AUV experienced problems with its propulsion system on the second day of the cruise. One good track at 2 m depth was completed before the propulsion system limited the operations of the AUV. Bluefin provided us excellent support in repairing the system and returning it to us in time to have the AUV ready to deploy during the last 5 days of the cruise. During the period that the AUV was not operable we remounted the instruments on a different package and have collected optical and physical measurements from the ship.

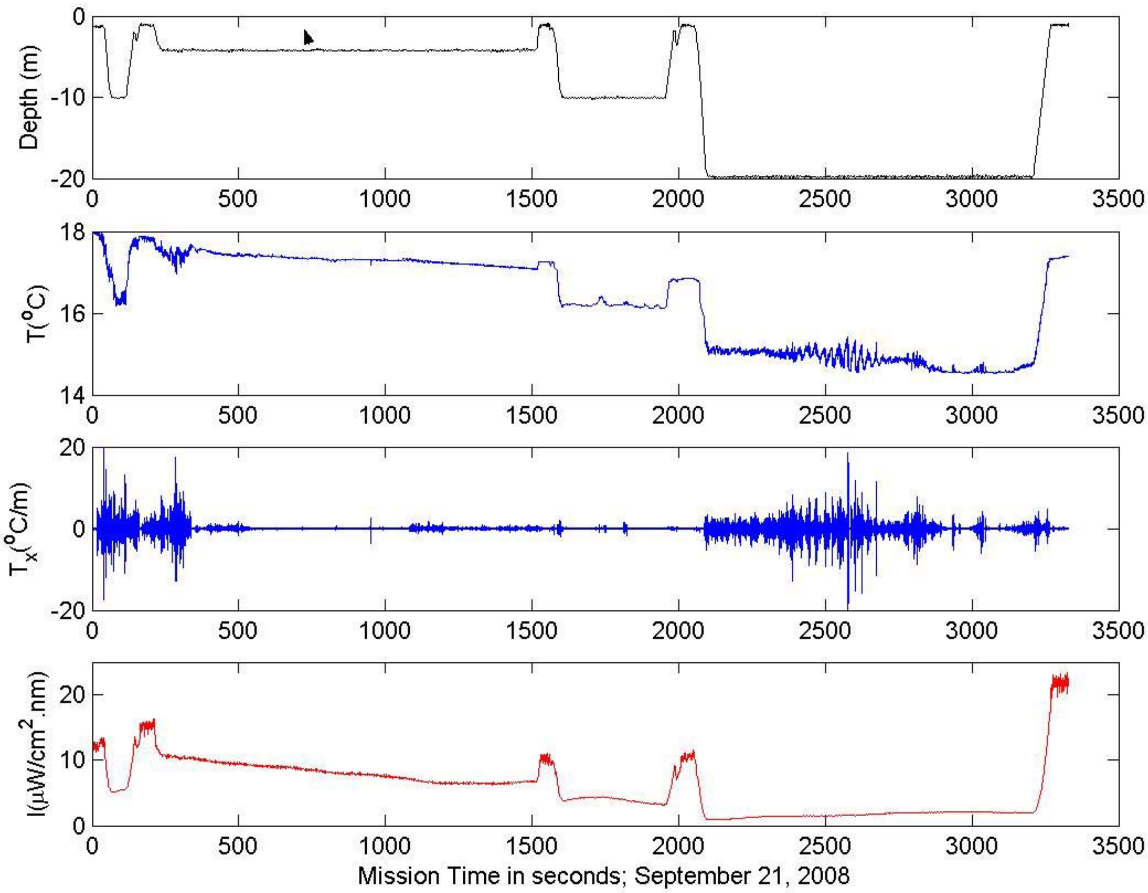

Figure 2. A trace of depth, temperature, temperature derivative and irradiance from a typical mission is shown. The temperature information provides an indication of the mixing occurring. A strong internal wave signal was seen at 20 m. The variations in the light field are masked by changes in magnitude with depth.

RESULTS

Because the cruise is in mid September we only have preliminary results to report. The most striking early result is the difference in irradiance spectra on heavily overcast days compared to clear (Figure 3). Where the high-frequency fluctuations are not present on overcast days. This is an expected result, but it is interesting in being able to quantify the difference.

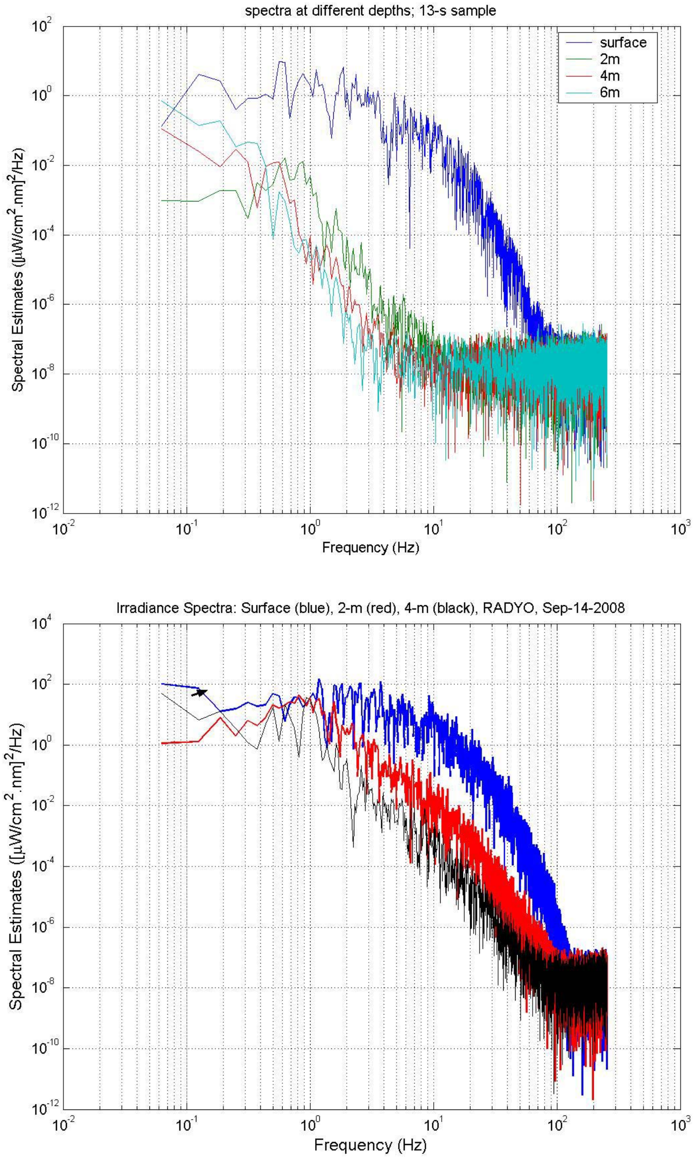

Figure 3. The upper panel contains the power spectra of the irradiance at the surface, 2, 4, and 6 m depth on a cloudy day. The lower panel contains the power spectra of the irradiance at the surface, 2, and 4 m depth on a clear day. The irradiance sensor has a minimum response time of 100 Hz. On the clear day the irradiance fluctuations are observed all the way to 100 Hz. On a cloudy day the fluctuations have a white spectrum at frequencies higher than 10 Hz.

IMPACT/APPLICATIONS

None

RELATED PROJECTS

Other projects participating in the RaDyO program, particularly the radiance camera project of Marlon Lewis. http://www.opl.ucsb.edu/radyo/

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